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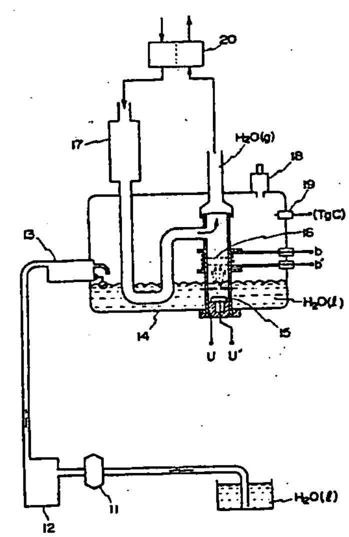
# (54) Method of obtaining mechanical energy utilizing multistep H2O-plasma.


(57) A method of obtaining mechanical energy utilizing multistep $H_2O$-plasma. A reactive thrust is produced by using plasma. The mechanical energy is produced by means of explosion of eletrically conductive plasma which is generated by dissociating $H_2O$. In a first step $H_2O$ (gas) produced by a carburretor is reduced to a plasmatic state by atmospheric discharge. In a second step the plasmatic gas is treated by further stronger atmospheric discharge and high-frequency induction heating, and the level of its energy is raised to a point such that a plasma jet is ready to be produced. In the third step plasma jet is generated by periodically modulating the high voltage for the second atmospheric discharge, and a high-pressure thermal explosion reaction is caused by synchronizing the generation with compression of the plasma jet resulting in that energy produced by the plasmatic reaction in the plasma jet at ultra-high temperature is converted to mechanical energy.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# METHOD OF OBTAINING MECHANICAL ENERGY UTILIZING MULTISTEP $H_2O$-PLASMA

Today, gasoline occupies an important position as a material for producing mechanical energy, but its use entails high cost and the waste produced causes environmental pollution. Various efforts have been made to eliminate and reduce such pollution for the maintenance of human health but these have not been very satisfactory.

This invention relates to a method of obtaining mechanical energy, wherein $H_2O(g)$ is generated in a cylinder from $H_2O$ (liquid) by a carburretor, and the $H_2O(g)$ is thereafter dissociated by multi-step atmospheric discharge and induction heating to generate electric conductive plasma, which is subsequently treated with a concentration of reactive free radicals therein to produce periodically plasma jet of temperature of thousands of degrees of Kelvin ($^{o}K$) at the centre of a cylinder by means of time gate modulation of high voltage for the discharge at the final step, then sharply increasing the degree of dissociation and compressing and igniting in synchronization therewith to induce an explosive reaction to obtain mechanical energy.

It is an object of the invention to provide a method to obtain mechanical energy using $H_2O$ as a reaction intermediary.

Another object of the invention is to provide a method for obtaining mechanical energy, utilizing substances in the combustible reaction which are completely free from pollution.

A further object of the invention is to provide a

method of obtaining mechanical energy in which thermal explosion reaction is caused using only hydrogen and oxygen produced by dissociation of $H_2O$.

The above and further objects of this invention will more fully appear from the following detailed description when the same is read in connection with the accompanying drawings, which are however only for the purpose of illustration and are not intended to limit the scope of the invention.

Fig. 1 is a schematic diagram to assist in explaining the relation of heat generation speed $V_1$ to heat dispersion speed $V_2$ in the explosion of a mixture of gases.

Fig. 2 is a diagram illustrating characteristics in relation to temperature $T(^{o}K)$ with pressure P(Pa) in a hydrogen explosion.

Fig. 3 is a schematic vertical sectional view of one of the examples of a carburretor used to produce $H_2O(g)$ from $H_2O(l)$ in the initial step.

Fig. 4 is a partly vertical fragmentary schematic view of the system of a turbo-diesel engine thermally insulated by ceramic compound which is an example of a device for carrying out the present invention.

Fig. 5 is a group of wave form diagrams illustrating the correlations of time phase of the series of pulses of external signals to operate the system and the series of gate modulation pulse controlling plasma jet, etc. in the form of a four-cycle engine in Fig. 4.

Fig. 6 is a schematic diagram of one form of electronic circuit system employed in Fig. 4.

Generally, when oxygen is mixed with combustible gas and a part of the mixture gas is ignited, the reaction will take place uniformly in the mixture gas, and reaction speed, that is, heat generation speed is remarkably high. On the other hand the heat dispersion is performed in a gas of low heat conductivity, so the heat generation speed is always higher than heat dispersion speed. This reaction is a so-called "unsteady-state

combustion" and as materials produced in the combustion are always gas or vapour, the unsteady-state combustion caused becomes explosive. Oxy-hydrogen detonating gas explosion and vaporized gasoline/air mixture explosion respectively belong to this type of explosion. Thus the explosion of the gas mixture is caused when the rate of heat generation by combustion exceeds that of heat dispersion and there is therefore a certain limit for a composition of mixture gas to explode.

Fig. 1 is the basic explanatory graph showing the relation of heat generation speed ($V_1$) with heat dispersion speed ($V_2$) when explosion takes place in a mixture of gas A with gas B, in which the X-axis represents concentration C of combustible gas A contained in the mixture gas, and is graded from left to right. At the left end point (B) on the X-axis, C=0% and oxygen (or air) is 100%, and at the right end point (A) on the axis, C=100% namely combustible gas, for example, hydrogen or gasoline is in 100%. Only at point (A) or (B) where concentrations are respectively 0% or 100% of combustible gas, the reaction speed, that is heat generation speed is at 0. Therefore both ends of the curve ($V_1$) are at zero point of the axis. The curve must reach the maximum at a certain point between these end points. On the other hand heat dispersion takes place even when gas A or gas B is at 100%, so the relation of the composition of gas mixture with heat dispersion speed can be shown by the curve ($V_2$), which must cross at certain points within a certain range on Y-axis on the end points (A) and (B), and this shows differences from curve ($V_1$) representing heat generation. Therefore at a given temperature, if the relative position of heat generation curve ($V_1$) with heat dispersion curve ($V_2$) is as indicated in Fig. 1, both curves cross each other at two points $K_1$, $K_2$, and at all points between the above two points where concentration of combustible gas is $C_1$ and $C_2$, heat generation speed ($V_1$) is above the heat dispersion speed ($V_2$). Therefore, at such a temperature

as described above, the use of gas mixture of composition falling between $C_1$ and $C_2$ will cause an explosion and such temperature corresponds to ignition temperature, or triggering temperature for the mixture gas of composition shown by $C_1$ and $C_2$. Practically, temperature which causes ignition in various mixture gas is near red heat temperature ($773^{\circ}K \sim 873^{\circ}K$) ($^{\circ}K$=Kelvin). Considering these, we can say that each gas mixture has a peculiar range of combustible composition of its own.

Combustible gas A described above is of hydrogen. We will describe hereinafter the explosion range of hydrogen. The range of explosion of hydrogen gas mixed with air is at $C_1 \simeq 4\% \sim C_2 \simeq 75\%$ in volume % (physics class 162 (578) P, "the Book of Chronological Scientific Data" published by Maruzen K.K., 1982). It is to be noted here that, in composition $C_2$, the upper limit for explosion, oxygen is considerably less than that which will cause complete combustion so long as air is used as source of hydrogen for the mixture gas. Because only with 1/5 volume of oxygen contained in 1 volume air, it is easily understood from simple computation, hydrogen concentration must be at about 30% or less in order that the air, by mixing it with hydrogen, turns completely to water after combustion. Comparison of this volume with the above-mentioned upper limit of hydrogen concentration $C_2 \simeq 75\%$ shows that the use of air as a source of oxygen allows complete combustion by hydrogen detonating gas explosion reaction only when hydrogen concentration is about less than 30%, and that oxygen is deficient for the combustion in the range above that hydrogen concentration. However, use of a container as a source of a hydrogen or oxygen is troublesome and above all dangerous, and less economical. In this point, the process according to the present invention in which $H_2O$ is utilized is characterized in that hydrogen and oxygen are rapidly dissociated from the $H_2O$ at an ultra-high temperature which is produced in a plasma jet generated at the final step in the multi-step

plasma generation (see the table). The plasma jet is compressed and ignited in a synchronized manner with the dissociation causing an explosion reaction in which oxygen is supplied neither from atmospheric air nor oxygen containers but from water to induce an oxy-hydrogen explosion reaction to obtain mechanical energy.

Fig. 2 is a brief explanatory graph on characteristics of temperature ($^{o}K$) vs. pressure (Pa) (Pascal) at explosion of oxy-hydrogen (2 volume hydrogen, 1 volume oxygen) in a container of glass. The detonation reaction can be expressed in a simple reaction formula $2H_2 + O_2 \rightarrow 2H_2O$, in which considerable heat of reaction is produced, that is $2H_2(g) + O_2(g) \rightarrow 2H_2O(g) + 115.6$ Kcal -----(1). In the case, heat generation volume amounts to more than twice that of gasoline per one gram. The reaction may seem simple at a glance, however, the mechanism itself is a complicated chain reaction in which the free radicals of H·, O· and ·OH concern each other. The characteristic curve taken at temperature T $770^{o}K$ in Fig. 2 indicates that no explosion occurs when pressure (p) is below point A, about $5.3 \times 10^2$ Pa, i.e. $Z_1$ zone, what is called a low pressure explosion takes place above point A up to B, about $5.3 \times 10^3$ Pa, i.e. $Z_2$ zone, and again no explosion occurs to point C, $8.0 \times 10^4$ Pa, i.e. $Z_3$ zone. However, where pressure (p) exceeds point C, i.e. $Z_4$ zone, it makes an area of a high-pressure explosion (also called a thermal explosion).

In a thermal explosion, speed of reaction increases rapidly, and speed of heat generation too increases rapidly at a certain temperature in proportion to an increase of pressure (p). The explosion in the present invention relates to explosion taking place in the area beyond point C.

Now,

*Start of Chain Reaction:

$$\begin{cases} H_2 \rightarrow 2H\cdot \text{-------}(2) \text{ or} \\ H_2 + O_2 \rightarrow HO_2 + H\cdot \text{ -------}(3) \end{cases}$$

*Propagation of Chain Reaction:

$$\begin{cases} H\cdot + O_2 \rightarrow \cdot HO_2 \text{-------}(4) \\ \cdot HO_2 + H_2 \rightarrow \cdot OH + H_2O \text{-------}(5) \\ \cdot OH + H_2 \rightarrow H_2O + H\cdot \text{-------}(6) \end{cases}$$

In the above reaction only one free radical is produced from one free radical which serves as a messenger in a chain reaction (referred to as MR for short from a Messenger Radical) and neither branching in the chain reaction nor explosion will take place. However when the following reaction takes place:

$$H\cdot + O_2 \rightarrow \cdot OH + O\cdot \text{-------}(7)$$

$$O\cdot + H_2 \rightarrow \cdot OH + H\cdot \text{-------}(8)$$

two free radicals are produced from each one MR, and the newly-borne MR's are composed of three, that is H·, O· and ·OH, which causes branching propagation in the chain reaction leading to explosion reaction. In the case the propagation of explosion is caused for the most part by adiabatic compression.

*Cutoff of Chain Reaction:

In gas, chain reaction is cut off by collision of MR's each other or by reaction, if any, on the wall of a container between MR's and the material of the wall.

$$H\cdot + H\cdot \rightarrow H_2 \text{-------}(9)$$

$$\cdot OH + H\cdot \rightarrow H_2O \text{-------}(10)$$

$$O\cdot + O\cdot \rightarrow O_2 \text{-------}(11)$$

The substrate produced by reaction with MR occurring on the ceramic wall of the container can, for the most part, be disregarded. It can be said that high pressure explosion is caused by the slower dispersion speed of what is called thermal molecules, atoms and free radicals with larger kinetic energy, than the appropriate cutoff speed of chain reaction. The fact that the explosion reaction of oxy-hydrogen detonating gas occurs in the above-mentioned chains reaction mechanism and that the reaction is initiated by free radicals of hydrogen H· can be confirmed by the combustion or explosion of hydrogen caused when H· produced in a different manner, for example, from

luminescent discharge in hydrogen gas, is led into a mixture of hydrogen/oxygen gas.

Fig. 3 is an explanatory diagram showing one of the examples of a carburretor in which $H_2O(g)$ is generated from $H_2O(l)$ in the initial step in the present invention. $H_2O$ is led from $H_2O(l)$ tank to fixed water level automatic control valve 3 through filter 11 by means of pump 12 and carburretor 14 is then supplied with $H_2O(l)$. An ultrasonic spray generator is provided in the carburretor and ultrasonic transducer 15 is driven to spray $H_2O(l)$ upwards by input of ultrasonic frequency from terminals U, U'. Heating W-net 16 is disposed in the spray of $H_2O(l)$ in order to rapidly gasify particulates of $H_2O(l)$ prior to the operation of the carburretor, and through terminals b, b', high frequency input is applied for induction heating. The spray is rapidly turned into $H_2O(g)$ which is in turn led to the intake of a turbo-supercharger. Once the equipment is put in operation, the exhaust is led from the turbo supercharger to the carburretor through a muffler, the waste heat of the exhaust heats $H_2O(l)$ in the carburretor, and joins itself in the flow of the above-mentioned gasified $H_2O(g)$ thereby to increase the temperature of $H_2O(g)$. The exhaust, being made up of $H_2O(g)$ for the most part, can be utilized to increase thermal efficiency by circulating the exhaust onto the supply side. Pressure relief valve 8 is disposed for keeping the pressure on a safe level, the pressure being increased as temperature of $H_2O(g)$ increases. Also temperature measure probe 19 is provided to obtain information necessary for electronically controlling the input of frequency for induction heating to appropriate temperature for control.

Fig. 4 is a schematic diagram of a turbo compound-ceramic adiabatic diesel system designed as an example of a device for carrying out the present invention.

When electric connection is effected with both carburretors referred to in the description of Fig. 3 and

turbo-fan axis drive-motor 21 of turbo-supercharger 20 in Fig. 4, the pinion gear of turbo-fan axis drive-motor 21 comes out and engages with ring gear 22 mounted on the axis 23 of the turbo-fan. Thereby the axis of the turbo-fan is put in rotation and $H_2O(g)$ from the carburretor is exhausted into intake-fan $20_a$ and further into the first discharge section $25(g_1)$ via intake manifold 24. High voltage $HV_1$ of repetition frequency $f_1$ (Hz), pulse height $|h_1|$ (KV) and discharge constant $T_1$ (sec) impressed between $P_1$ and $P_1'$ causes atmospheric discharge in the first discharge section $25(g_1)$ to generate anisothermal plasma (electron temperature Te $\gg$ ion temperature Ti $\gtrsim$ gas temperature), the first step, which is in turn led into the second discharge section 17 through intake valve 26. The intake valve is, prior to operation, closed depending upon the position on which piston ring 31 linked with connecting rod 33 stops, in which case plasma gas generated in the first discharge section $25(g_1)$ stagnates in a space in front of intake valve 26, before it is opened by pressure of the gas. The second discharge section $27(g_2)$ is a section disposed in interval $g_2$ between a conductor 28 disposed on an extension of axial centre of ceramic cylinder 32 behind intake valve 26 and the inner wall of the ceramic cylinder. Unmodulated high voltage $HV_2$ of repetition frequency $f_2$ (HZ), pulse height $|h_2|$ (KV) and discharge constant $T_2$ (sec) is impressed between terminals $P_2$, $P_2'$ simultaneously with initiation of the first discharge. Thus the high voltage initiates atmospheric discharge in the second discharge section $27(g_2)$ too. The second step anisothermal plasma generation thereby takes place. In anisothermal plasma in $H_2O(g)$, reactive free radicals H·, O· and ·HO are produced together with ions $H_2O^+$, $H_3O^+$, $OH^+$, $H^+$ which are the most part in quantity, and $H^-$, $O^-$, $OH^-$ ions as intermediate products.

$\frac{|h_2|}{g_2} > \frac{|h_1|}{g_1}$ is given in order to intensify plasma energy

in the second steps more than plasma energy in the first step. To provide pool effect in generating radicals of plasma at the first step,

$f_1 \geqq f_2$ ---------------(12)

$T_1 \gg T_2$ $O(10^{-7}$ sec) (O is order) -------(13)

$T_2$ is put in $10^{-7}$ sec order to avoid uncontrolled explosion, if ever to happen, in the second discharge section.

Simultaneously, with the discharge caused, plasma gas (having conductivity) in front of conductor 28 in the second discharge section $27(g_2)$ is surfacted to induction heating using high-frequency waves of frequency $f_i$ (HZ) (preferably with $f_i \approx O,(10^8$HZ)) to increase the temperature of plasma gas in plasma jet generator 29 in front of conductor 28 at centre up to the level of controlled temperature $(Tg_3)$'s predetermined immediately before the generation of plasma jet. It is preferred that $f_i$ be of the order of $10^8$ HZ, for such order makes it possible for gas ionization to be promoted by trapping for electrons as well as making non-electrode discharge possible at the same time. Terminals a, a' are for input of induction heating high-frequency $f_i$(HZ) from outside of the ceramic tube. As so far described, the starting switch of crank shaft 34 has not been turned on, that is these steps are preparation which is followed by an operation step.

A fly wheel is disposed at an end of crank shaft 34 and a ring gear is mounted on the outer side thereof (these are not shown in Fig. 4). When the starting switch is turned on, a motor starts rotating and a pinion gear is engaged with the ring gear to bring crank shaft 34 into operation. The other end of crank shaft 34 is provided with a crank shaft gear which rotates the crank shaft by engagement with a camshaft gear. When the camshaft rotates, intake and exhaust valves are driven by means of the cam attached thereto. These mechanical operations are not related to the present invention and are part of the known art and can be designed in various manners.

No detailed presentation has therefore been made in Fig. 4.

Rotation of crank shaft 34 gives trigger pulse D from a distributor cam linked therewith (see Fig. 5), thereby repeated gate G with variable range $\Delta tg$ initiating from a position of appropriate timely preceding phase $\phi$ to ignition time of supplemental ignition plug $P_3$, $P_3'$ mounted to cylinder is made, then gates $G_1$, $G_2$, $G_3$, $G_4$ are made from the gate G to control each cylinder. With this high voltage $HV_2$ which has not been modulated before operation increases its peak value by gate modulation from $|h_2|$ (KV) to $|h_{gm}|$ (KV) ($(HV_2)_1$, $(HV_2)_2$, $(HV_2)_3$, $(HV_2)_4$ in Fig. 5). The temperature of plasma electrons in the second discharge section 17 of ceramic cylinder is then increased impulsively and periodically to rapidly increase concentration of reactive free radicals and the plasma gas thus generated is subsequently jetted forward into high frequency thermal plasma gas portion in front of conductor 18 (Fig. 4). Gate-controlled plasma jet is thereby generated with core temperature registering to thousands degrees of Kelvin (°K), the thermal dissociation reaction of $H_2 \rightleftarrows 2H$, $O_2 \rightleftarrows 2O$ is caused, and the degree of dissociation of H-atoms and O-atoms reaches to such levels, according to computation as shown in the following table:

| Temperature of plasma | 1,000 | 2,000 | 3,000 | 4,000 | 5,000 (°K) |
|---|---|---|---|---|---|
| Dissociation degree of H | $1.3 \times 10^{-9}$ | $8.8 \times 10^{-7}$ | $8.3 \times 10^{-2}$ | $63 \times 10^{-2}$ | $95 \times 10^{-2}$ |
| Dissociation degree of O | $9.0 \times 10^{-11}$ | $3.6 \times 10^{-4}$ | $5.9 \times 10^{-2}$ | $60 \times 10^{-2}$ | $96 \times 10^{-2}$ |

That is, as understood from the table, the range of oxy-hydrogen explosion is realized when the temperature of plasma registers 3,000 °K and over.

Now the thermal pinch effect in the plasma jet in the ceramic cylinder will be explained. As the plasma in the cylinder is of lower temperature in the outer part thereof due to the inflow of the intake gas, ionization of gas is diminished on the upper surface of the plasma and electric conductivity has been reduced, that is electric resistance has been increased. Thus electric current is concentrated towards the core part of the plasma and increases the temperature therein. Such increased temperature promotes ionization of gas and electric conductivity of the plasma is increasingly augmented to produce larger heating effects - this is called "thermal pinch effect". The temperature in the plasma is further raised owing to the magnetic pinch effect by the magnetic field inducedly caused thereby, then the plasma shrinks and ultra-high temperature is produced in the thermal plasma. In Fig. 4, 26 is temperature measure probe ($Tg_1$) and 27 is temperature measure probe ($Tg_3$) respectively.

As understood from Fig. 5, the above-mentioned gate-controlled plasma jet can be generated by repetition of frequency $f_c$ (HZ) obtained in $f_c = \frac{2}{N}$ (HZ) -------(14) for a four-cycle engine (an engine hereinafter referred to as a four-cycle engine except otherwise specified) in which N (r.p.s.) is rotation of crank shaft 24 per second. In case of two-cycle engine, formula (14) becomes $f_c = \frac{1}{N}$ (HZ) -------(14'). At this step, the repetition of the explosion can be electronically controlled by synchronizing compression and ignition with the repetition of $f_c$ (HZ). In this way, the engine starts to operate. And, high voltage $HV_3$ supplied to supplementary ignition plugs $P_3$, $P_3'$ in Fig. 4 wherein pulse height $\approx$ more than 10 KV, discharge constant $T_3$ ($T_1 > T_3 \gg T_2$), is to assist compression ignition when the engine starts, and is thereafter put off and the engine remains operative only by compression of plasma jet. Exhaust gas produced in the process according to the present invention is made up mainly of $H_2O$(g) containing waste heat, and this is

exhausted by exhaust valve 20 and through exhaust manifold 25 led to operate the turbo supercharger, thereafter the exhaust gas is eventually introduced to carburretor 4 through muffler 7 as shown in Fig. 3 to provide the $H_2O(g)$ waste heat to the carburretor as $H_2O(g)$ for supply. When the engine starts and turbo-fan axis 13 of the turbo supercharger begins to rotate (Fig. 4), turbo-fan axis drive motor 11 disengages automatically pinion gear from ring gear 12.

A description of the time range $\Delta tg$ of a modulation gate of this invention will now be given. In the aforesaid formula (14), when the maximum value of N (r.p.s.) is at $N_{max}$ (r.p.s.), we have,

$$f_c(MAX) = \frac{2}{N_{max}} \text{ (HZ) } \text{-------(15)}$$

A gasoline engine can now be designed to provide the maximum rotation of $15 \times 10^4$ r.p.m. of crank shaft 24. In other words, ignition frequency of an ignition plug will reach 1,250/second which is from $1/2 \times 15 \times 10^4 - 60 = 1{,}250$. One of the examples thereof is as shown in $N_{max} = 15 \times 10^4 - 60 = 2{,}500$ (r.p.s.). In order to obtain at least one explosion within the gate range $\Delta tg$ under a condition of $f_c(MAX)$, it is required that one or more high voltage pulse HV (KV) with repetition of $f_2$(HZ) is given in the time range $\Delta tg$. To obtain this purpose, the following conditions will be sufficient.

$$\frac{1}{f_2} < \Delta tg \text{ -------(16)}$$

$$f_2 > f_c(MAX) \text{ -------(17)}$$

From G in Fig. 5, the upper limit of $\Delta tg$ is

$$\Delta tg < \frac{1}{4f_c} \text{ -------(18)}$$

From the formulas (16) and (18),

$$\frac{1}{4f_c} > \Delta tg > \frac{1}{f_2} \text{ ---------(19) and}$$

From formulas (12) and (17)

$$f_1 \geqq f_2 > f_c \text{ (MAX)} \text{ -------(20)}$$

Moreover, electron behaviour can be accelerated, after start-up of the operation by regulating $\Delta t_g$ shown in G in Fig. 5.

Fig. 6 is a schematic diagram of a comprehensive electronic system for the carburretor in Fig. 3 and the apparatus for carrying out this invention (a four-cycle engine) as illustrated in Fig. 4 under conditions given by formulas (12)~(20), wherein 41 is high frequency oscillator of frequency $f_i \sim O(10^8 \text{ HZ})$ and P.A.C. $(Tg_3)_1 \approx (Tg_3)_s$ refers to a power amplifier, whose output to terminal $a_1$, $a_1'$ for induction heating is electronically controlled to be $(Tg_3)_1 \approx (Tg_3)_s$, and $(Tg_c)$ is at an appropriate temperature of $H_2O(g)$ in carburretor which is determined in advance. 42 indicates an ultrasonic oscillator of frequency $f_u \sim O(2 \times 10^4 \text{ HZ} \sim 10^6 \text{ HZ})$ and P.A.C.N. indicates a power amplifier whose output to terminal U, U' for the transducer is electronically controlled in proportion to N(r.p.s.). 43 is a pulse oscillator of repeating frequency $f_1 \geqq f_2$ at least O(3 KHZ), and P.A.M.$G_1$ indicates a power amplifier whose output is electronically modulated by gate $G_1$. 44 is a trigger pulse from distributor cam contact for gate modulation.

Electric power for pre-starting through start-up stages is supplied from a battery. After the start-up, a charging generator is operated for power generation and the voltage of power generated is kept constant by a voltage regulator for avoiding overcharge. An automatic current breaker checks backflow of the current from the battery to the generator. Similar mechanism and operations as provided for in conventional engines are not described.

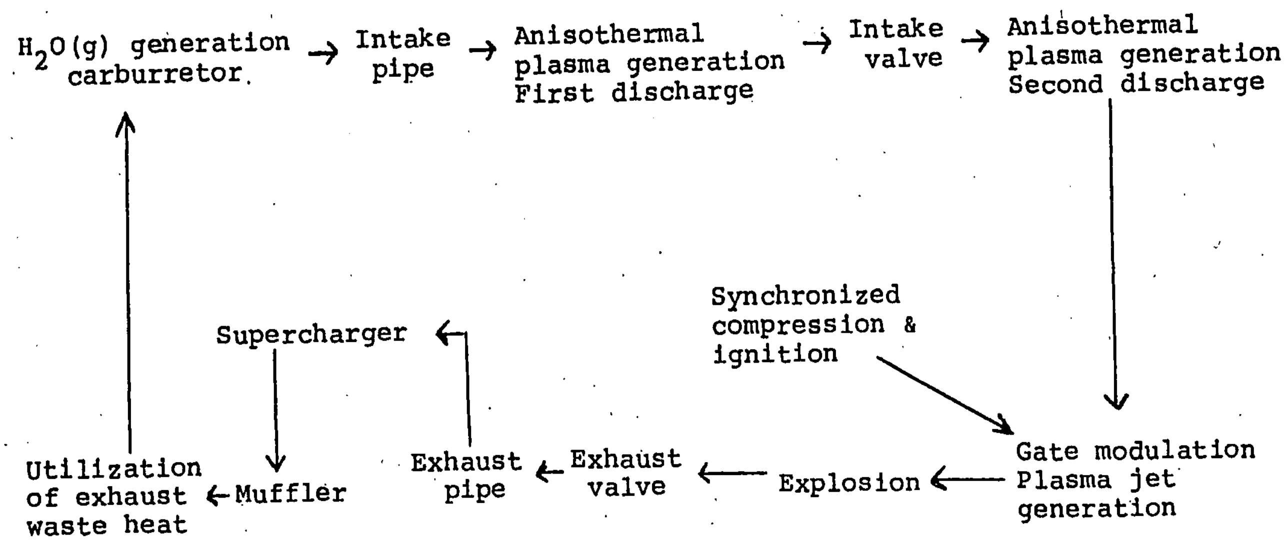
In the apparatus which is used for carrying out this invention illustrated in Fig. 4, it is not necessary to atomize all the taken $H_2O(g)$ for complete dissociation. The method of this invention is designed to increase in turn concentration of reaction free radicals in the energy-raised plasma which is produced from the $H_2O(g)$ at

the first and second steps, then to produce plasma gas of high electron temperature impulsively and periodically by the time-gate modulation at the final step, and further to make plasma jet of as high as several thousand degrees Kelvin ($^{O}K$) locally which is subjected to explosion by means of synchronized compression. Accordingly it is very important to impart the thermal pinch effect and the magnetic pinch effect sufficiently to the plasma jet. For the purpose of the above operation, one causes the plasma to contract by lowering the peripheral temperature of plasma with the inflow of $H_2O(g)$ taken in as described earlier. Consequently, it is preferable to leave in the plasma some $H_2O(g)$, since it helps to raise the inner temperature of the plasma jet.

Another advantage of leaving in the plasma some $H_2O(g)$ is that $H_2O(g)$ molecules provide a kind of catalytic effect to facilitate the reaction of hydrogen and oxygen. As shown in formula (1), in the oxygen/hydrogen reaction, calorific value per gram is more than twice that of gasoline. In the case of the engine exemplified in Fig. 4, what percentage of mechanical energy obtained after start-up can be utilized for charging the generator to supplement the battery, and what percentage can be utilized as mechanical energy for the planned usage of the engine depends on design. Thus with respect to usage of the energy obtained, various designs can be used.

In the method of the present invention, a cycle system as shown below can be tightly insulated from outer air. It follows therefore that the principle can be applicable to plasma jet propulsion in astronautical space.

Flow Process Chart of System



The method of this invention having the above illustrated structure, can use water alone dispensing with oil fuel or even oxygen in the air as well as hydrogen or oxygen container, to take out mechanical energy in the form of periodically repeated explosions in multi-step generated plasma. The method is free from environment pollution.

CLAIMS:

1. A method of obtaining mechanical energy in a series of steps of $H_2O$-plasma, which comprises: a first step of generating $H_2O(g)$ (vapour) by a carburretor, and gasifying the $H_2O(g)$ to a plasma state by an atmospheric discharge; a second step of intensifying the state of energy of the gasified plasma to a level ready to generate plasma jet by more intensified atmospheric discharge than that in the first step and high-frequency induction heating; and a third step of generating plasma jet by periodical modulation of the high voltage for the second atmospheric discharge, and causing a high-pressure thermal explosion reaction by compression of the plasma gas in synchronization with the modulation, and thereby converting the energy produced by the plasma reaction at an ultra-high temperature in the plasma jet into mechanical energy.

2. A method of obtaining mechanical energy utilizing multistep of $H_2O$-plasma, as claimed in Claim 1, wherein the vaporization of $H_2O(1)$ (water) is performed by ultrasonic and induction heating.

3. A method of obtaining mechanical energy utilizing multistep of $H_2O$-plasma, as claimed in Claim 1, wherein the modulation of high voltage of electricity, the compression of plasma gas synchronized therewith and the generation of plasma jet in the third step are selectively performed by input of external signal.

4. A method of obtaining mechanical energy utilizing multistep of $H_2O$-plasma, as claimed in Claim 2, wherein the modulation of high voltage of electricity, the compression of plasma gas synchronized therewith and the generation of plasma jet in the third step are

selectively performed by input of external signal.

5. A method of obtaining mechanical energy utilizing multistep of $H_2O$-plasma, as claimed in Claim 3, wherein the input of external signal is automatically performed by a repeated movement of mechanical measures provided by mechanical energy converted from energy generated in the plasmatic reaction.

6. A method of obtaining mechanical energy utilizing multistep of $H_2O$-plasma, as claimed in Claim 4, wherein the input of external signal is automatically performed by a repeated movement of mechanical measures provided by mechanical energy converted from energy generated in the plasmatic reaction.

FIG. 1

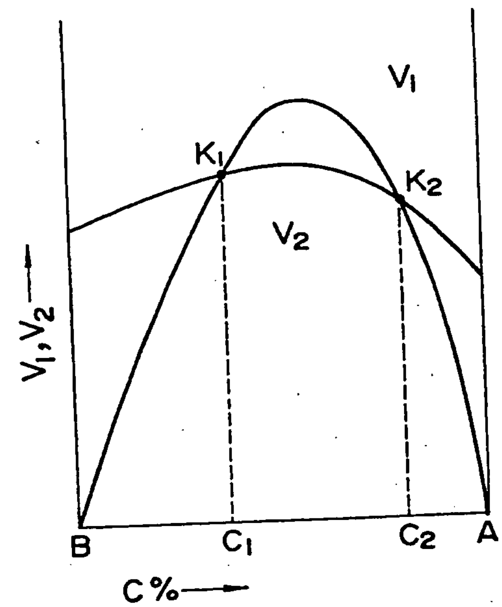

V1
K1
K2
V2
V1, V2
B
C1
C2
A
C %

FIG. 2

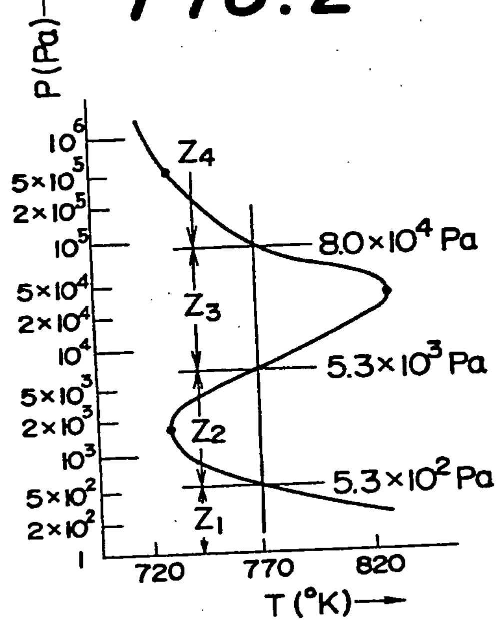

P (Pa)
10^6
5×10^5
2×10^5
10^5
5×10^4
2×10^4
10^4
5×10^3
2×10^3
10^3
5×10^2
2×10^2
1
Z4
Z3
Z2
Z1
8.0×10^4 Pa
5.3×10^3 Pa
5.3×10^2 Pa
720
770
820
T (°K)

FIG. 3

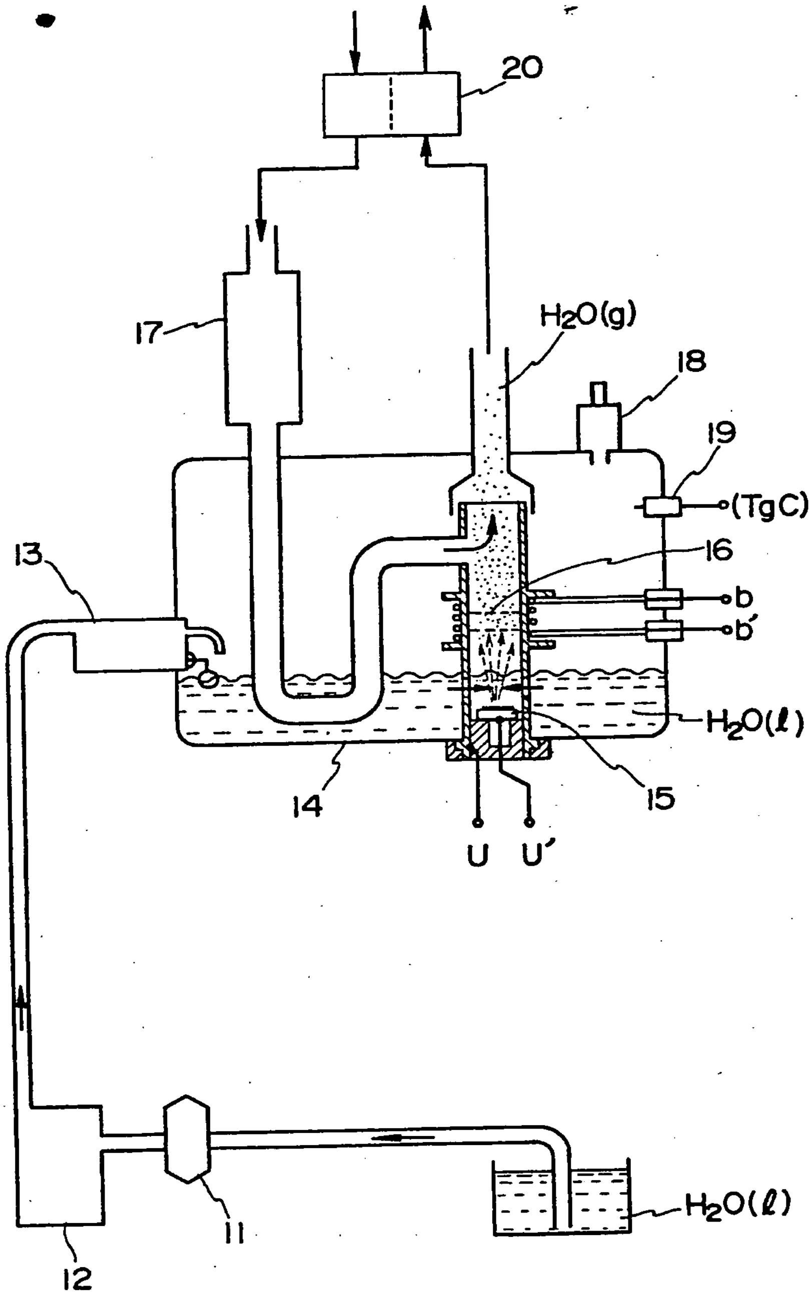


FIG. 4

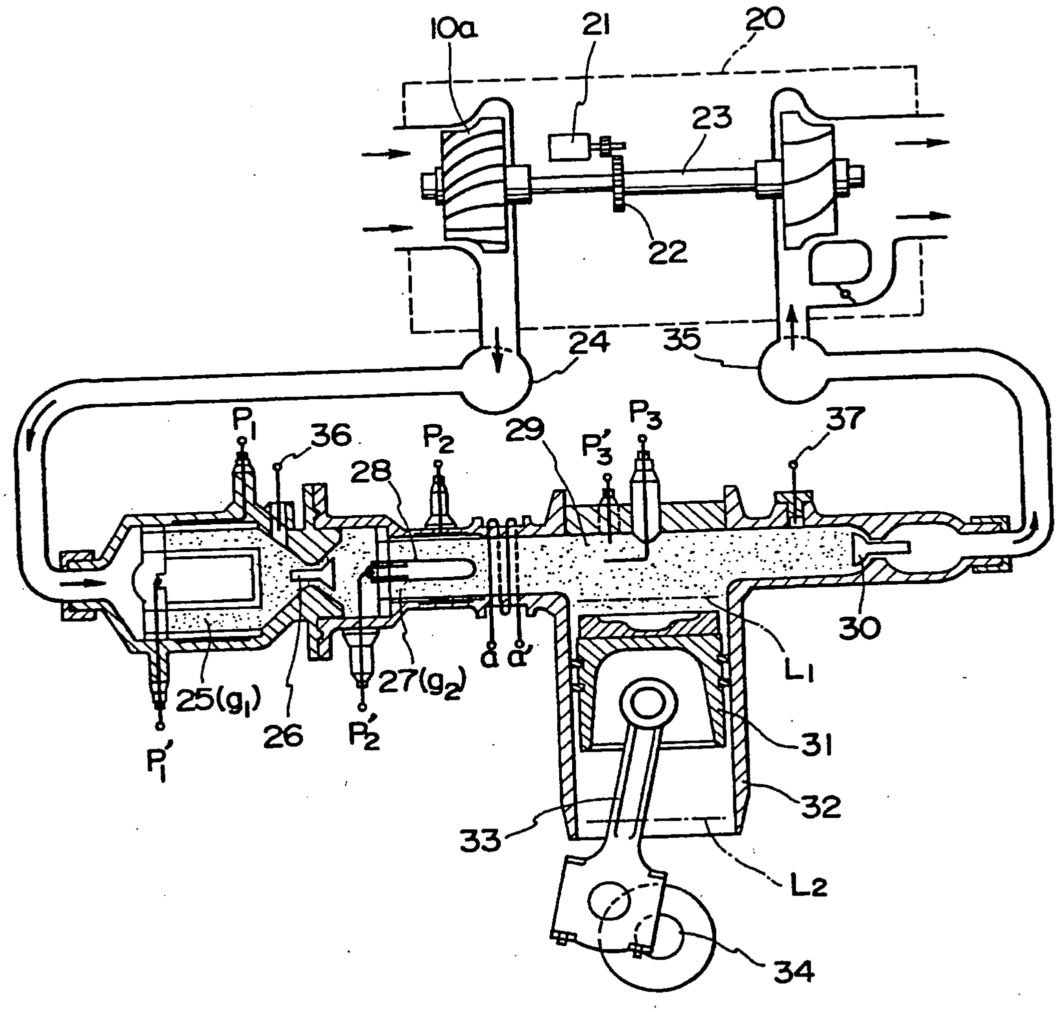
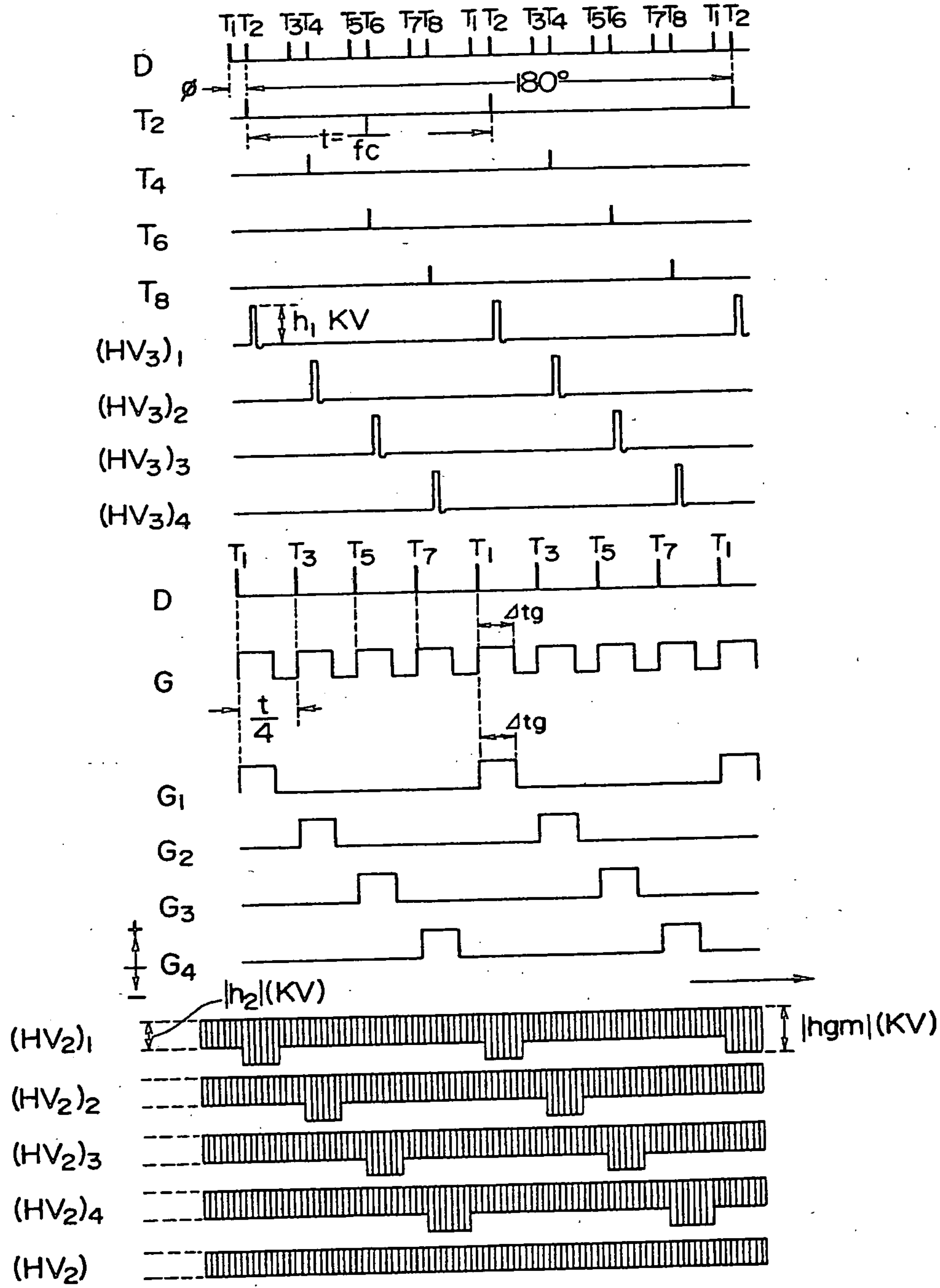
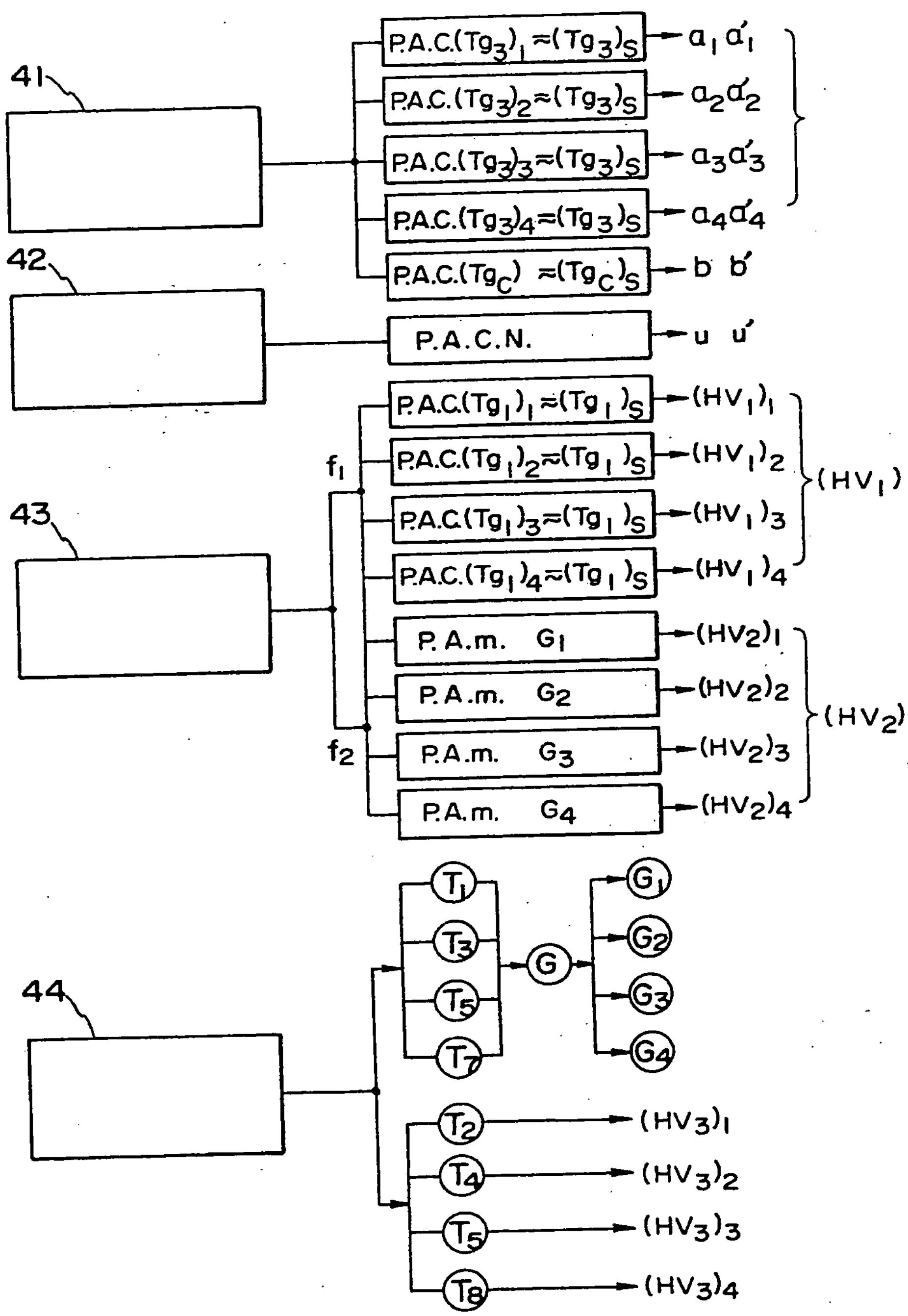

10a
21
20
23
22
24
35
$P_1$
36
$P_2$
28
29
$P_3'$
$P_3$
37
30
$L_1$
$P_1'$
25($g_1$)
26
$P_2'$
27($g_2$)
a
a'
31
32
33
$L_2$
34

FIG. 5



T1 T2 T3 T4 T5 T6 T7 T8 T1 T2 T3 T4 T5 T6 T7 T8 T1 T2
D
ø
180°
T2
t = 1/fc
T4
T6
T8
h1 KV
(HV3)1
(HV3)2
(HV3)3
(HV3)4
T1 T3 T5 T7 T1 T3 T5 T7 T1
D
Δtg
G
t/4
Δtg
G1
G2
G3
G4
+
−
|h2|(KV)
|hgm|(KV)
(HV2)1
(HV2)2
(HV2)3
(HV2)4
(HV2)

FIG. 6


41
P.A.C.$(Tg_3)_1 \approx (Tg_3)_S$
$a_1\ a'_1$
P.A.C.$(Tg_3)_2 \approx (Tg_3)_S$
$a_2\ a'_2$
P.A.C.$(Tg_3)_3 \approx (Tg_3)_S$
$a_3\ a'_3$
P.A.C.$(Tg_3)_4 \approx (Tg_3)_S$
$a_4\ a'_4$
P.A.C.$(Tg_C) \approx (Tg_C)_S$
b b'
42
P.A.C.N.
u u'
43
$f_1$
P.A.C.$(Tg_1)_1 \approx (Tg_1)_S$
$(HV_1)_1$
P.A.C.$(Tg_1)_2 \approx (Tg_1)_S$
$(HV_1)_2$
P.A.C.$(Tg_1)_3 \approx (Tg_1)_S$
$(HV_1)_3$
P.A.C.$(Tg_1)_4 \approx (Tg_1)_S$
$(HV_1)_4$
$(HV_1)$
$f_2$
P.A.m. $G_1$
$(HV_2)_1$
P.A.m. $G_2$
$(HV_2)_2$
P.A.m. $G_3$
$(HV_2)_3$
P.A.m. $G_4$
$(HV_2)_4$
$(HV_2)$
44
$T_1$
$T_3$
$T_5$
$T_7$
G
$G_1$
$G_2$
$G_3$
$G_4$
$T_2$
$(HV_3)_1$
$T_4$
$(HV_3)_2$
$T_5$
$(HV_3)_3$
$T_8$
$(HV_3)_4$